CLAIMS

What is claimed is:

1. A method for forming an alloy substantially free of dendrites, comprising the steps of:
   a. cooling a superheated alloy to form a nucleated alloy, wherein the nucleated alloy includes a plurality of nuclei, wherein essentially all of said nuclei are substantially free of entrapped liquid;
   b. controlling the temperature of the nucleated alloy to prevent the nuclei from melting;
   c. mixing the nucleated alloy to distribute the nuclei throughout; and
   d. cooling the nucleated alloy with nuclei distributed throughout, thereby forming an alloy substantially free of dendrites.

2. The method of Claim 1, wherein the superheated alloy is cooled at a rate of at least 15°C per second to form the nucleated alloy.

3. The method of Claim 2, wherein the superheated alloy is cooled at a rate in the range of about 20°C per second to about 30°C per second to form the nucleated alloy.

4. The method of Claim 1, wherein the superheated alloy includes at least one of the materials selected from the group consisting of aluminum, lead, tin, magnesium, manganese, strontium, titanium, silicon, iron, carbon, copper, gold, silver, and zinc.

5. The method of Claim 1, further includes the step of using the alloy substantially free of dendrites in at least one application selected from the group consisting of a thixocasting application and a rheocasting application.

6. The method of Claim 1, wherein the mixing of the nucleated alloy is accomplished by directing the nucleated alloy through a passive mixer.

7. The method of Claim 1, wherein the alloy substantially free of dendrites includes a primary particle size of about 100 microns or less.

8. The method of Claim 7, wherein the alloy substantially free of dendrites includes a primary particle size of about 70 microns or less.

9. The method of Claim 1, wherein the alloy substantially free of dendrites includes a shape factor value in the range of about 0.75 and about 0.95.

10. The method of Claim 1, further includes the step of quenching the nucleated alloy to form the alloy substantially free of dendrites.

11. The method of Claim 1, wherein the superheated alloy includes at least one grain-refining agent.

12. The method of Claim 11, wherein the grain-refining agent includes at least one of the materials selected from the group consisting of borides of titanium and borides of aluminum.

13. The method of Claim 11, wherein the grain-refining agent includes at least one of the materials selected from the group consisting of TiB_2, AlB_2, TiC, and Al_3Ti.

14. The method of Claim 1, wherein the superheated alloy is heated to at least about 5°C above the liquidus temperature.

15. The method of Claim 14, wherein the superheated alloy is heated to a temperature in the range of between about 10°C to about 15°C above the liquidus temperature.

16. The method of Claim 1, further includes the step of forming a billet from the alloy substantially free of dendrites.

17. The method of Claim 1, wherein at least a portion of the superheated alloy includes a metal recycled from a metal-forming process.

18. The method of Claim 1, further includes the step of directing the alloy substantially free of dendrites to a metal-forming process.

19. The method of Claim 18, wherein the alloy substantially free of dendrites directed to a metal-forming process includes a volume fraction of solids of at least about 30%.

20. The method of Claim 19, wherein the alloy substantially free of dendrites directed to a metal-forming process includes a volume fraction of solids in the range of from about 40% to about 60%.

21. A continuous process for forming an alloy substantially free of dendrites, comprising the steps of:

a. directing a superheated alloy stream into a reactor, wherein the superheated alloy stream is continuously cooled and mixed to form a nucleated alloy stream, wherein the nucleated alloy stream includes a plurality of nuclei distributed throughout, wherein essentially all of said nuclei are substantially free of entrapped liquid; and

b. continuously controlling the temperature of the nucleated alloy stream to prevent the nuclei from melting and continuously mixing the nucleated

alloy stream to distribute the nuclei throughout, thereby continuously forming an alloy substantially free of dendrites.

22. A method for forming an alloy substantially free of dendrites, comprising the steps of:

a. cooling a superheated alloy to form a nucleated alloy, wherein the nucleated alloy includes a plurality of nuclei, wherein essentially all of said nuclei are substantially free of entrapped liquid;

b. controlling the temperature of the nucleated alloy to prevent the nuclei from melting and passively mixing the nucleated alloy to distribute the nuclei throughout; and

c. cooling the nucleated alloy with nuclei distributed throughout, thereby forming an alloy substantially free of dendrites.

23. A method for forming an alloy substantially free of dendrites, comprising the steps of:

a. superheating a first metal;

b. superheating a second metal;

c. mixing the first and second metals to form a superheated alloy;

d. cooling the superheated alloy to form a plurality of nuclei, wherein essentially all of said nuclei are substantially free of entrapped liquid;

e. mixing the superheated alloy to distribute the plurality of nuclei throughout the superheated alloy;

f. controlling the temperature of the superheated alloy to prevent the nuclei from remelting; and

g. cooling the superheated alloy while the nuclei are distributed throughout, thereby forming an alloy substantially free of dendrites.

24. The method of Claim 23, wherein the fist metal comprises a dissimilar composition from the second metal.

25. The method of Claim 23, wherein each of the at least two metals are heated to nonequal temperatures.

26. The method of Claim 23, wherein the first metal is heated to a temperature in a range of between about 1°C and about 50°C above the liquidus temperature of the second metal.

27. The method of Claim 23, wherein the second metal is heated to a temperature in a range of between about 1°C and about 50°C above the liquidus temperature of the second metal.

28. An alloy substantially free of dendrites formed by a method comprising the steps of:

a. cooling a superheated alloy to form a nucleated alloy, wherein the nucleated alloy includes a plurality of nuclei, wherein essentially all of said nuclei are substantially free of entrapped liquid;

b. controlling the temperature of the nucleated alloy to prevent the nuclei from melting;

c. mixing the nucleated alloy to distribute the nuclei throughout; and

d. cooling the nucleated alloy with nuclei distributed throughout, thereby forming an alloy substantially free of dendrites.